F.X.R.

MODEL B812A

STANDING WAVE AMPLIFIER

INSTRUCTION MANUAL

WEINSCHEL ENGINEERING

GAITHERSBURG, MARYLAND

MP MASTER

MA35911

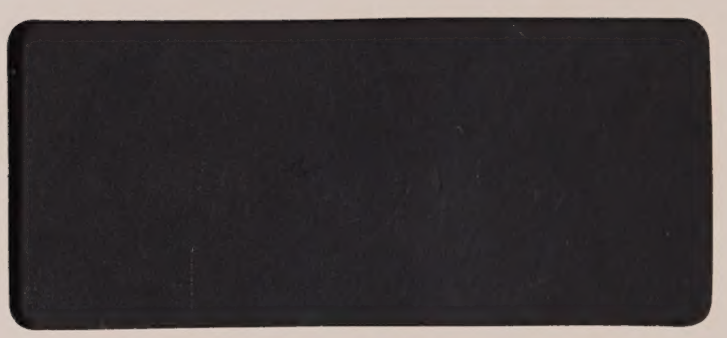

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Figure 1. FRONT VIEW of MODEL B812A,
STANDING WAVE AMPLIFIER

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SECTION I
DESCRIPTION

1.1 GENERAL. The Type B812A Standing Wave Amplifier is a tuned audio amplifier that, in conjuction with a square law detector, can be used to measure VSWR or attenuation over a 70 DB range.

Features that add to the convenience of making these measurements include: A tunable 950 to 1050 cps filter to allow for individual tuning of each amplifier in the measuring system. A low microphonic subminiature tube in the input stage is used to increase the usable sensitivity under adverse operating conditions. An eye level tilting meter housed in an independent enclosure, which also may be removed from the amplifier cabinet for remote operation. The independent meter housing contains a vernier attenuator to permit remote meter adjustments over a 3 DB range. The meter itself is a 5 inch 1% mirrored back unit which provides for increased reading accuracy and helps prevent operator fatigue. Precision resistors and careful construction maintain a ±0.1 DB accuracy per decade range. The maximum accumulative range-to-range error is 0.2 DB over the full 70 DB instrument range. In addition to the 7 position, 10 DB per position switch, a gain control permits a sensitivity adjustment over a 12.5 DB range with a vernier control over a 0.8 DB range. A special +5 DB switch position permits more accurate measurements by avoiding the crowded regions of the meter scale. Expanded scale operation is also provided for the precise measurement of low VSWR and attenuation. An input selector switch provides for 200 ohm or 200,000 ohm crystal operation, or 200 ohm bolometer operation at a bias of either 4.5 or 8.75 Ma. The B812A has an equivalent input noise level of 0.03 microvolts. An input signal of 0.1 microvolts will produce a full scale meter reflection and deliverya 1 Ma current, at the recorder output jack located at the back of the instrument, into a 600 ohm load.

SECTION II
MEASUREMENT of VSWR

2.1 GENERAL. The meter scale on the amplifier has been calibrated for direct reading of voltage standing wave ratios, either as a ratio or in DB. This calibration is based on the use of a square law detector. When they are correctly used, crystals and many types of bolometer detectors are closely square law.

A silicon crystal detector such as a 1N21, 1N23, 1N26, or 1N53 can be used only at very low R.F. power levels to make accurate measurements. A generally acceptable upper level is reached when the input R.F. power produces one millivolts of rectified D.C. Therefore, when taking measurements it is important to keep the R.F. power at the detector below this level.

Wollaston wire bolometers, such as the Series 220 Bolometers are more accurately square law than crystals and are, therefore, used for more precise measurements. However, bolometers, too, deviate from square law detection at high levels. The maximum power level is dependent upon the size and construction of the bolometer. The deviation from square law is usually less than with crystals. The major disadvantage of bolometers over crystals is that they are less sensitive.

2.2 VSWR MEASUREMENTS USING A CRYSTAL. Using the circuit as shown in block form in Figure 1a, proceed in the following order:

a. Set the amplifier controls as indicated below;
   Input - Crystal, 200K ohms or 200 ohms as required.
   Gain - Completely clockwise.
   VSWR-DB -30.
   Frequency - 1000 cps.
   Meter - Normal

b. Be certain that the R.F. oscillator is operating and that it is modulated at an audio frequency within the range from 950 to 1050 cps.

c. Set the R.F. probe well into the transmission line and then tune (if the probe has tuning provision) for maximum indication on the meter.

d. Adjust frequency control for maximum meter indication.

*e. Adjust the probe insertion for full scale meter deflection on the "10" or "20" VSWR-DB position.

*To assure square law operation always select the most sensitive usable amplifier gain position.

f. Move the probe to a position that gives maximum meter indication. Using either the gain controls on the amplifier or the R.F. attenuator, adjust the meter to read 1 on the VSWR scale (0 on the DB scale).

g. Move the R.F. probe to a position of minimum pickup. Switch the VSWR-DB range as needed to obtain a usable reading at the minimum pickup position.

h. The VSWR is now indicated directly on the meter. For example if the readings on the three VSWR scales are 1.9, 6, 5.5 DB, the VSWR would be 1.9 or 5.5 DB if the VSWR-DB switch was not changed from step g. If the VSWR-DB switch was reduced one position then the VSWR would be 6 or 15.5 DB. Each additional position reduction on the VSWR-DB switch adds 10 DB to the VSWR or changes the ratio in the following range order:

VSWR -	1 - 3
	3 - 10
	10 - 30
	30 - 100
	100 - 300
	300 - 1000
	1000 - 3000

The initial setting in step f. can be made on any VSWR-DB range since the VSWR ranges listed above are not dependent upon level.

2.3 +5 DB SWITCH POSITION. If the meter indication in step h., Section 2.2 above occurs in the down scale crowded region of the meter, the +5 DB switch position on the front panel may be used to obtain a more accurate reading. This switch position adds an additional 5 DB gain to the signal thus enabling the meter readings to be shifted from the lower portion of one range to the upper portion of that same range. In reading the attenuation, add 10 DB for each DB range switch position, and an additional 5 DB for the +5 DB switch position, to the meter indication.

Example - A maximum full scale meter adjustment is obtained as in steps e. and f., section 2.2 with the DB range selector switch set on "10 DB". A minimum position indication as in step g., Section 2.2 is obtained with the DB range selector switch in the "20 DB" position. The meter reads on the VSWR scales between 2 and 2.2 on the top scale and 6 and 6.5 on the next meter scale. (On the DB meter scale the reading is between 6 and 7 DB.) For a more ac-

curate reading we position the meter selector switch on the +5 DB position. The meter now gives indications of 1.15, 3.64 VSWR and 1.2 DB. The attenuation is now 1.2 DB + (1)(10 DB) + 5 DB = 16.2 DB. Meter reading plus 10 DB for each range position plus 5 DB for +5 DB position switch equals DB attenuation.

2.4 EXPANDED SCALE. The expanded scale can be used if the VSWR is less than 1.3 (2.2 DB if the DB scale is being used). Set the meter switch on the front panel to "EXPAND". The VSWR will be indicated directly on the meter on the EXPANDED VSWR or EXPANDED DB scale.

2.5 VSWR MEASUREMENTS USING A BOLOMETER. A bolometer does not convert R.F. energy directly to D.C. as does a crystal. instead, the detecting action of a bolometer is based on the effect that a bolometer has on an auxiliary D.C. circuit. When R.F. power is dissipated in the thin bolometric resistance wire, the temperature of the wire rises. This rise in temperature changes the resistance of the bolometer. (The bolometer is a square law detector since the change in resistance is proportional to the R.F. power.) When a bolometer with a short time constant -- such as a Type 220 Bolometer is used with a modulated R.F. source, the resistance change follows the audio modulation. By passing a constant D.C. current through the bolometer a voltage at the modulation frequency is obtained across the bolometer. Because of the square law characteristics of the bolometer this audio voltage is proportional to the R.F. power.

The B812A Standing Wave Amplifier has an internal D.C. bias supply designed to operate bolometers on this principle. This supply can be used with bolometers that require a biasing current of 4.5 or 8.75 Ma.

Using the circuit shown in block form in Figure 1, proceed in the following order:

NOTE

Do not connect the bolometer until correct adjustments are made.

a. Set the amplifier controls as indicated below;
Meter - Normal
Input - Crystal, 200 ohms
Gain - Completely clockwise
VSWR-DB -30
Frequency - 1000 cps.

b. Set the frequency of the R.F. modulator to 1000 cps.

c. Attach the bolometer and then turn the input selector switch to the proper bolometer bias.

d. Set the R.F. probe well into the transmission line and then turn (if the probe has tuning provisions) for maximum indication on the meter.

e. Adjust the frequency control to peak the amplifier indication.

f. Adjust the probe insertion for full scale meter deflection on the 10 or 20 VSWR-DB position.

g. Follow steps f., g., and h. in Section 2.2 above for the measurement procedure.

NOTE

Bolometers are delicate devices which cannot survive excessive overload. However, there are bolometer types that are normally operated so close to the burnout power level that even the slightest transient will destroy them. Rather than take the risk of burning out an expensive element, it is recommended that the following simple procedure be followed.

Always turn the input selector switch to crystal before connecting the bolometers to the amplifier. Turn the switch to bolometer only after a secure connection has been made.

2.6 REMOTE METER OPERATION. The meter on the FXR Type B812A Standing Wave Amplifier may be removed from the amplifier cabinet to provide remote meter indications at distances up to 6 feet from the VSWR amplifier.

To remove the meter loosen and withdraw the two captive thumbscrews on the sides of the amplifier cabinet. Remove the meter and uncoil the meter cable on the back of the separate meter enclosure. A vernier control located on the top of the meter enclosure will permit a vernier meter adjustment over a 3 DB range. This control must be turned to its full clockwise position before the meter is replaced in the amplifier cabinet.

SECTION III
MEASUREMENT of ATTENUATION

3.1 GENERAL. A second important use for the Type B812A Standing Wave Amplifier is the measurement of attenuation at microwave frequencies. Such measurements are usually made using a detector with a known square law response. Either a crystal or a bolometer is recommended. See Section 2.5, Measurement of VSWR.

For more accurate measurements increased reading accuracy can be had by using a logarithmic meter in place of the one supplied with the amplifier. This can be easily accomplished through the use of a voltmeter, such as the Ballantine Model 300 connected to the output jack of the amplifier in shunt with a 500 ohm resistor.

3.2 PROCEDURE. This procedure outlined below is for a bolometer detector used in the circuit shown in Figure 1b.

NOTE

Do not connect the bolometer until correct adjustments are made.

a. Set the amplifier controls as indicated below;
Meter - Normal
Input - Crystal
Gain - Completely clockwise
VSWR - DB -30
Frequency - 1000 cps.

b. Set the frequency of the R.F. modulator to 1000 cps.

c. Set the attenuator pad to limit the R.F. power to a level that will not destroy the bolometer.

d. Attach the bolometer and then turn the input selector switch to the proper bolometer bias.

e. Adjust the R.F. power level for usuable reading. Then adjust the frequency control to peak the meter indication.

f. With the R.F. attenuator under test set to zero, set either the Gain control or the R.F. level to obtain a reading of 0 DB on either the 0 to 10 DB scale.

g. Insert the attenuation to be measured and read the value directly on the DB meter scale. Add 10 DB for each step that the VSWR-DB swith is advanced. For example, let the initial set in step f. be on VSWR-DB switch position 0 and the meter set to 0 DB. If the final reading, after inserting the unknown attenuator, is on

VSWR-DB switch position 30 and the meter reading is 5 DB, then the attenuation is; 5 DB (meter reading) + 30 DB (three step advances of the VSWR-DB switch) = 35 DB.

NOTE

Read explanation of the following caution at the end of Section 2.5 above.

Always turn the detector switch to crystal before connecting the bolometer to the amplifier. Turn the switch to bolometer only after a secure connection has been made.

SECTION IV
CIRCUIT DESCRIPTION

4.1 GENERAL. The Type B812A Standing Wave Amplifier is an audio amplifier with special features for convenience in measuring the standing wave ratio or attenuation on coaxial or waveguide transmission systems. A circuit diagram for the amplifier is shown at the end of this section. The B812A is basically a high gain, 1000 cycle tuned, printed wiring amplifier, meter and regulated power supply.

4.2 CIRCUITRY. The input stage of the tuned amplifier utilizes a subminiature low microphonic tube to increase the usable sensitivity under adverse operating conditions. An input selector switch provides matched inputs of 200,000 ohms and 200 ohms. When used in the 200 ohm position a well shielded input transformer provides the matching and an additional 30 DB noise free gain. Bolometer bias of 4.5 or 8.75 Ma D.C. is also selected by the input selector switch. The maximum open circuit bias voltage is limited to 1.4 or 5.4 volts depending on the bolometer range. The equivalent input noise level is 0.03 microvolts. An input signal of 0.1 microvolts will produce a full scale meter deflection and at the same time provide a 1 Ma current into a 600 ohm load at the recorder output jack.

The gain of the amplifier is controlled by a decade attenuator switch (VSWR-DB range selector) located in the inputs of the first three amplifier stages and two section concentric shaft potentiometer gain control located in the input to the fourth stage. The decade attenuator provides 120 DB of attenuation in 6 - 20 DB steps. Since the instrument is calibrated for a square law detector the meter scale front panel markings are in 10 DB steps. Precision resistors maintain accuracies to 0.1 DB per range with a maximum accumulative range-to-range error of 0.2 DB over the full 70 DB range. The gain control provides a coarse adjustment over a 25 DB range (or 12.5 DB on the meter scale) and a fine adjustment with the rear control over a 1.6 DB range (0.8 DB on the meter).

The +5 DB meter switch position is obtained by a 5 DB attenuator switch in the input to the third stage. The expanded meter scale operation is controlled by this same switch but with another section and the circuitry located in the output stage. This function is obtained by introducing a 1.85 Ma current of opposite polarity into the meter circuit. To prevent biasing the diodes in the forward direction equal voltages are applied to both diodes.

The frequency selective network is at the input to the meter amplifier stage. It is composed of a tapped variable toroidal inductor. A close tolerance polystyrene capacitor and silver mica trimming capacitors are utilized to maintain stability. The variable inductor provides a tuning range from 950 to 1050 cps. The Q of the circuit is approximately 25 with a band width of 40 cps.

The gain of the meter amplifier stage is directly proportional to the impedance of the diode rectifier load. The output current and meter indication is therefore independent of the load resistance and directly proportional to the voltage input to the meter amplifier stage.

The series connected 12AU7 amplifier, NE-2 reference source and 6BQ5 pass tube comprise an electronically controlled constant 300 volt power supply with an impedance less than 50 ohms. The power supply maintains very low ripple while its low impedance aids in preventing feedback between the stages. The heaters of the entire amplifier are biased at a positive B+ voltage to reduce hum pickup.

SECTION V
ADJUSTMENT and CALIBRATION

5.1 GENERAL. The B812A has been carefully tested and calibrated by the manufacturer. It has been shipped ready for use. It will not normally require recalibration except after maintenance or servicing operation.

5.2 RECALIBRATION PROCEDURE. The entire recalibration procedure may be accomplished without removing the unit from its cabinet.

5.2.1 METER MECHANICAL ZERO ADJUSTMENT. With the power off and the unit in its proper physical position adjust the zero adjust screw located on the meter housing directly below the center of the scale.

5.2.2 POWER SUPPLY.

5.2.2.1 A.C. LINE. Check power line for proper 60 cycle voltage. Plug in the B812A, turn power on and allow 5 minute warm-up period before proceeding.

5.2.2.2 B+ SUPPLY. The B+ supply 250 V may be measured between the case ground and the B+ test point located at the rubber grommet on the main enclosure point behind the meter enclosure. DO NOT attempt to touch (with your meter test prod) the printed circuit board behind the grommet, but only the test point wire located in the grommet. The voltage at this point is adjusted to 250 volts with the potentiometer located diagonally below the test point.

5.2.3 BOLOMETER CURRENT. Connect a 200 ohm precision resistor across the input connector. Set the input selector switch to 4.5 Ma. Connect a high impedance D.C. voltmeter across the 200 ohm resistor. Adjust bolometer bias control for 4.5 Ma. This control is located above and slightly to the left of the B+ test point. Exercise care to assure that the screwdriver blade does not touch the panel while performing this adjustment. Switch the input selector to 8.75 Ma. The D.C. voltmeter should now read 1.75 volts.

5.2.4 EXPANDED METER SCALE. Set the input selector switch to 200,000 ohms, the range switch to 30 DB and the meter selector switch to the EXPAND position. Apply a 1000 cycle signal through a calibrated adjustable attenuator and adjust for a full scale "0" DB meter reading. Attenuate the signal 4 DB. The meter should read 2 DB on the expanded scale. If not, adjust the expanded scale bias control (located 2" below the B+ test point) so that the meter reads an equal but opposite error. Repeat the procedure starting with a full scale (0 DB) meter reading. When the proper adjustment has been made, switch the meter selector back to the "normal" position. Adjust the input for a full scale deflection. Switch the meter selector to the EXPAND position and adjust the expand gain control (located on the horizontal position of the front panel) for a full scale deflection on the expanded meter scale.

5.3 LINEARITY CHECK. Set the input selector switch to 200 K ohms, the gain control to maximum, range to 0 DB and meter selector switch to normal. Apply a 1000 cycle signal through a calibrated attenuator to the input and adjust for a full scale deflection. Attenuate the signal in 10 DB voltage steps and observe a corresponding attenuation indication on the meter in 5 DB steps. Continue through all the ranges. Repeat the same procedure with the input selector switch set to 200 ohms. The accuracy is ± 0.1 DB per range with a maximum accumulative range-to-range error of 0.2 DB, when not limited by noise.

5.4 NOISE AND SENSITIVITY. Set the input selector for 200 ohms crystal, gain control to maximum, meter switch to +5 DB and range switch to 60 DB. Introduce a 0.1 microvolt signal through a calibrated attenuator with a 200 ohm termination. Adjust the gain control for a full scale deflection. Disconnect the signal generator and observe at least a 6 DB attenuation.

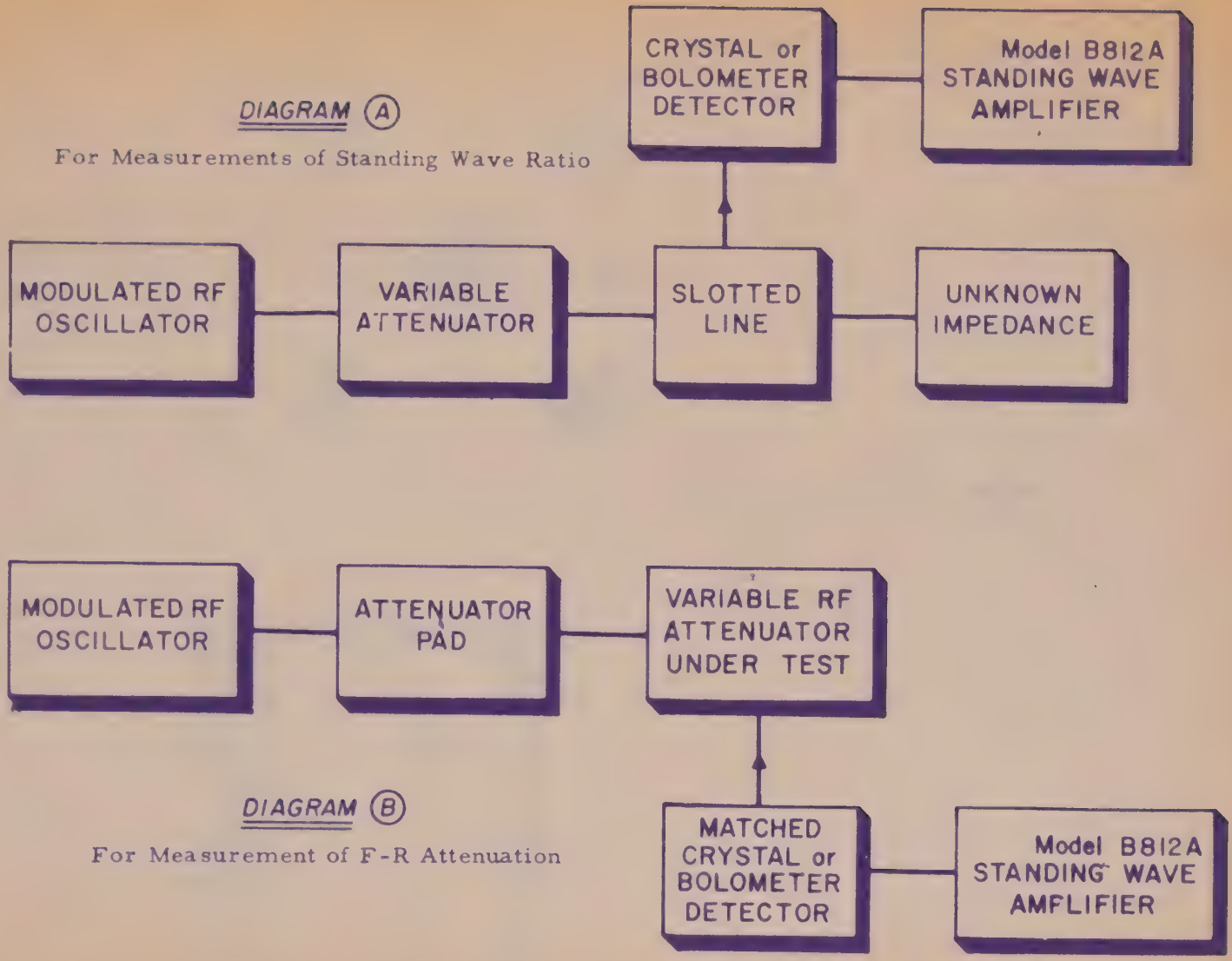
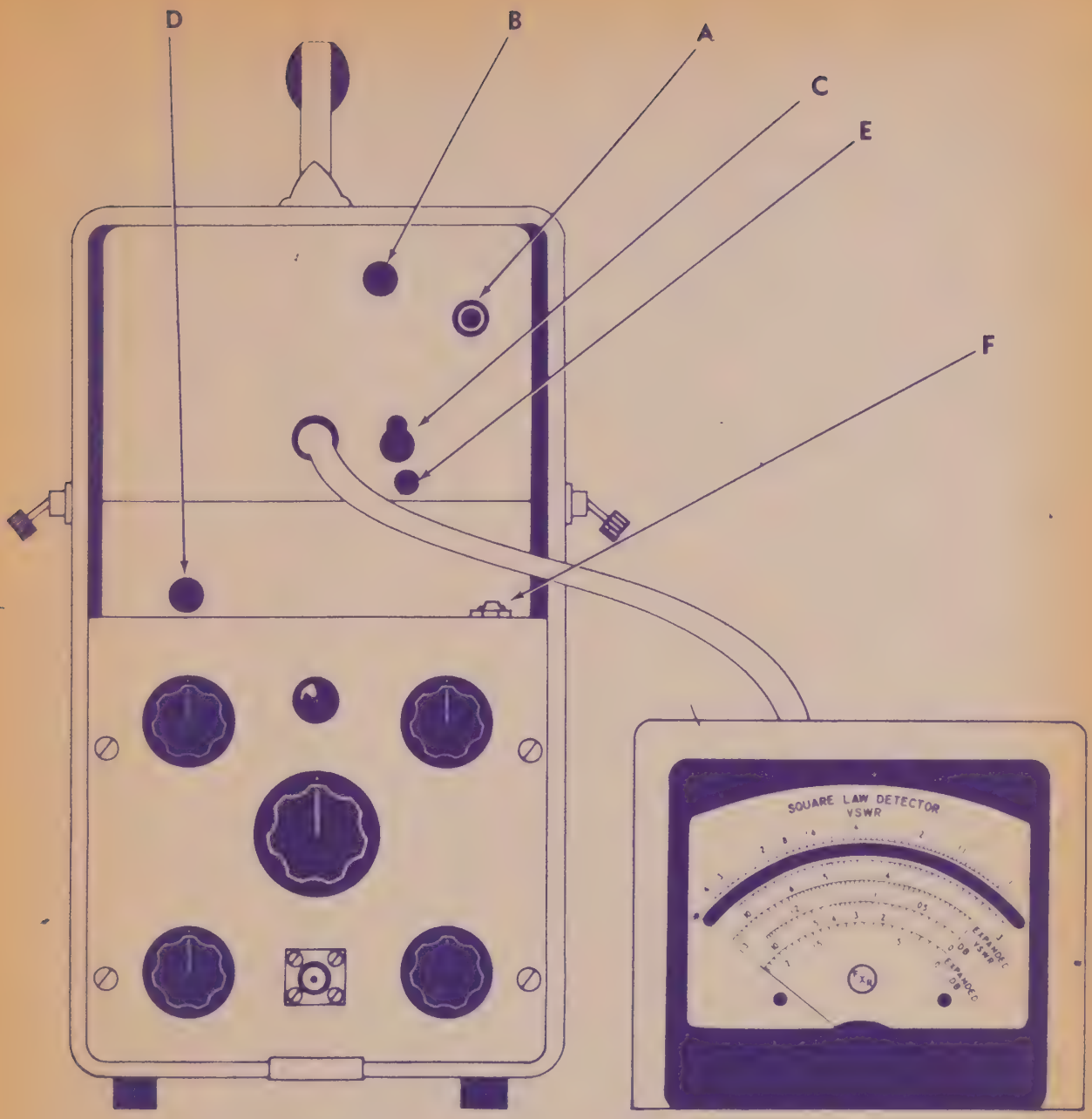
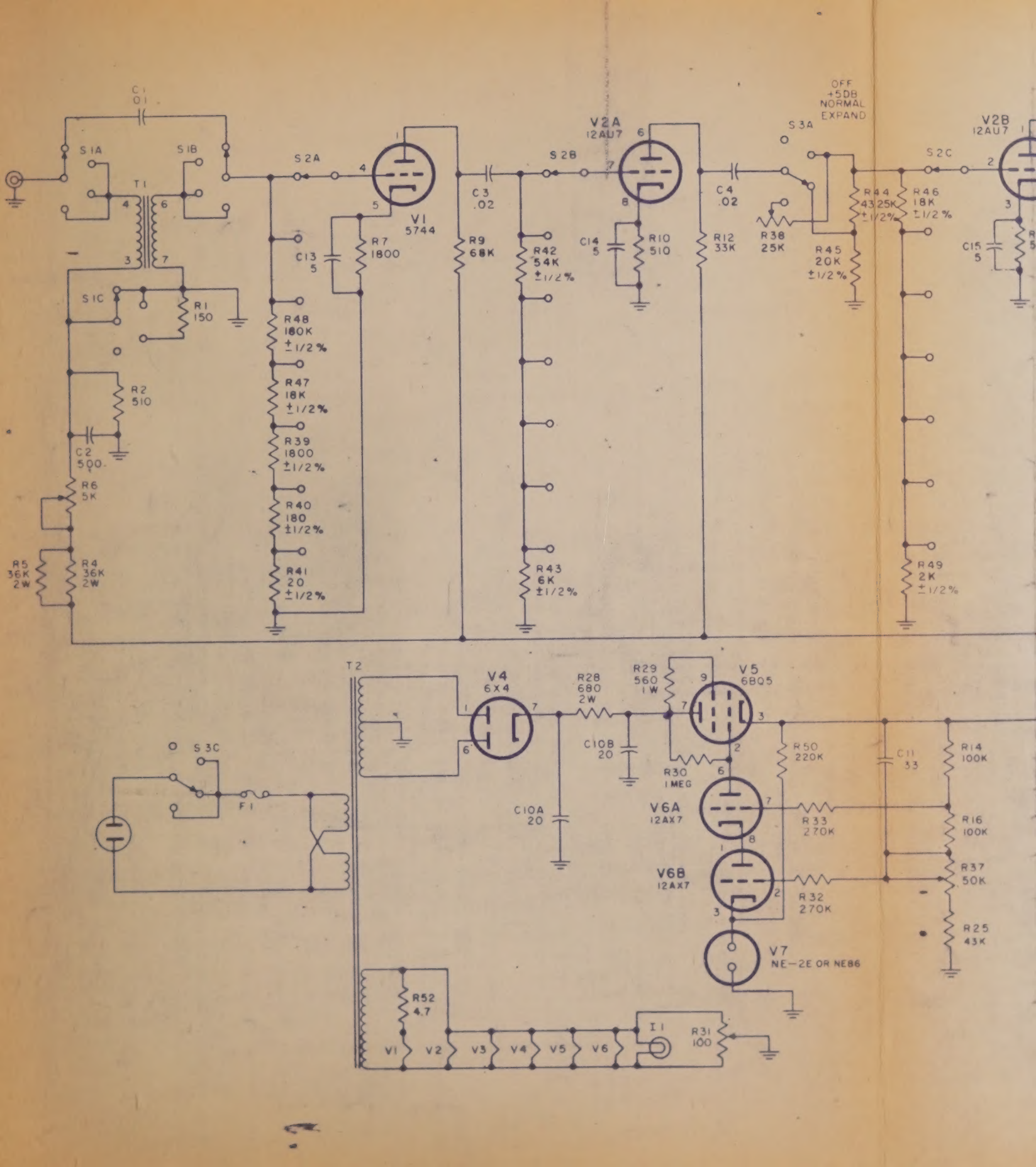


Figure 2. TYPICAL APPLICATION for MODEL B812A STANDING WAVE AMPLIFIER



A. B+ Test Point.
B. Bolometer Bias Adjustment (R6)
C. Expanded Scale Bias (R36)
D. B+ Adjustment (R37)
E. Hum Balance (R31) (Serial #189 and over)
F. Expanded Scale Gain (R38)

Figure 3, Standing Wave Amplifier with Meter Removed.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S1A
S1B
T1
S2A
V1
5744
C13
5
R7
1800
R9
68K
C3
.02
S2B
V2A
12AU7
C14
5
R10
510
R12
33K
C4
.02
S3A
OFF
+5DB
NORMAL
EXPAND
R38
25K
R44
43.25K
±1/2%
R45
20K
±1/2%
R46
18K
±1/2%
S2C
V2B
12AU7
C15
5
S1C
R1
150
R48
180K
±1/2%
R47
18K
±1/2%
R39
1800
±1/2%
R40
180
±1/2%
R41
20
±1/2%
R42
54K
±1/2%
R43
6K
±1/2%
R49
2K
±1/2%
R2
510
C2
500
R6
5K
R5
36K
2W
R4
36K
2W
T2
V4
6X4
R28
680
2W
R29
560
1W
V5
6BQ5
C10B
20
C10A
20
R30
1MEG
V6A
12AX7
V6B
12AX7
R50
220K
R33
270K
R32
270K
C11
33
R14
100K
R16
100K
R37
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R25
43K
S3C
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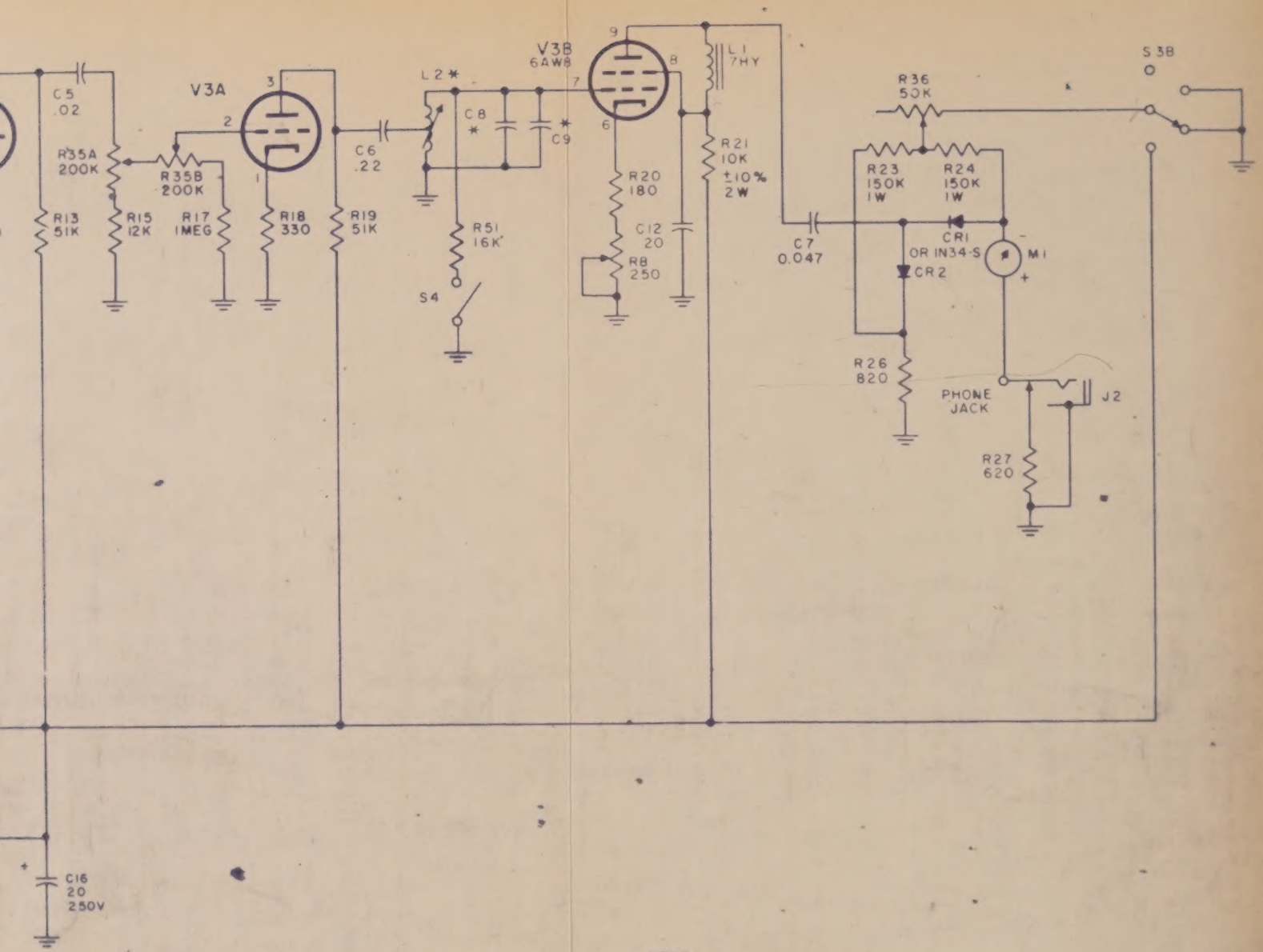
V5
V6
I1
R31
100



NOTES

1. ALL CAPACITANCES ARE IN UF.
2. ALL RESISTANCES ARE IN OHMS. ±5%, 1/2W UNLESS OTHERWISE NOTED.
3. * ARE TUNED TO 1000CY. FACTORY ADJ.

STANDING WAVE AMPLIFIER B812A 301567

SERIAL NOS FROM 393 & UP

MP MASTER
MA35911

93920